

SENN (N.)

DELAYED

—AND—

NON-UNION OF FRACTURES.

BY N. SENN, M. D.,
MILWAUKEE, WIS.



[Abstract of a Lecture delivered to the Rock River Medical
Society, at the Milwaukee Meeting, September 5, 1883.]

[*Reprinted from the "Weekly Medical Review" of
September 29, 1883.*]

Published by J. H. CHAMBERS & Co.,
CHICAGO, ILL., AND ST. LOUIS, MO.

DELAYED

—AND—

NON-UNION OF FRACTURES.

BY N. SENN, M. D.,
MILWAUKEE, WIS.

[Abstract of a Lecture delivered to the Rock River Medical
Society, at the Milwaukee Meeting, September 5, 1883.]

[*Reprinted from the "Weekly Medical Review" of
September 29, 1883.*]

Published by J. H. CHAMBERS & Co.,
CHICAGO, ILL., AND ST. LOUIS, MO.





DELAYED AND NON-UNION OF FRACTURES.

BY N. SENN, M.D., MILWAUKEE, WIS.

The study and management of fractures have always constituted interesting topics to the general practitioner. Fractures are of frequent occurrence in every community, and every physician is expected to exercise ordinary skill in their treatment. In assuming the treatment of a fractured limb we also assume grave responsibilities in law and equity, which demand of us the exercise of diligence and at least ordinary skill.

In civil courts negligence on the part of the attendant has, and ought to have, no defense. The medico-legal responsibility of the surgeon is only too frequently made the subject of litigation in the class of injuries embraced in the subject now under consideration. It is a well known fact that many cases of delayed and non-union are made the basis for mal-practice suits, wherein, on the part of the prosecution, the defendant in technical language is made to answer to a charge of ignorance or negligence irrespective of the cause or causes which may have prevented the ideal result in these cases—bony consolidation with fragments in good position. In all these cases the defendant labors under great disadvantages in court, inasmuch as the popular idea is prevalent everywhere, that a broken bone once properly set must unite by bone, and in good position. The layman is ever ready to admire bone-setting as a great art, but can never be made

to comprehend the difficulties encountered in many cases in maintaining the fragments in constant, uninterrupted apposition. Before considering the conditions which may give rise to delayed or non-union, it may be well to refer briefly to the processes which nature employs in uniting a broken bone. The process of repair after fractures has for centuries been a favorite subject for study, experiment and investigation on the part of the most distinguished surgeons and pathologists. Galen regarded callus as a substance thrown out about the seat of fracture for the purpose of cementing the ends of the broken bone together, without however being capable of conversion into bone. This doctrine met with no opposition until Van Swieten asserted that the new material in the course of time is transformed into bone.

J. L. Petit taught that bone-injuries are repaired in a manner similar to injuries of soft tissue, the process in bone being modified only by the density of its own tissue. Duhamel-du-Monceau recognized the bone-producing function of the periosteum and endosteum, while Haller looked upon callus as the product of the fractured ends of the bones themselves, more especially the myeloid tissue. Dupuytren introduced the terms provisional and definitive callus, attributing the formation of the former to the periosteum and soft tissue around the seat of fracture, while the latter is the product of the bone-producing function of the bone and marrow. He made the important and practical observation, that the definitive callus does not make its appearance until four to five months after the injury, and that its completion requires from eight to twelve months.

Bransby B. Cooper associated the formation of callus with inflammation, believing that it is the conjoined product of all the inflamed tissues in the fractured ends of the broken bone. Lambron advocated the possibility of primary union between

the bone-ends under certain favorable circumstances, through the medium of an interfragmentary callus independently of the existence of a provisional callus. Virchow, Rokitsansky, Gegenbauer and Hein regard the connective tissue in bone, periosteum and adjacent soft parts as the most important and essential osteo-genetic structure. Hofmøhl classifies the tissues from which callus is produced in the following order: periosteum, marrow, bone.

Rigal and Vignal, in a series of well conducted experiments, have carefully studied the influence of the circulation on the formation of callus.

The following is a summary of their conclusions: If periosteum is exposed to a moderate degree of irritation, new bone is produced from the marrow beneath the point of irritation without passing through the stage of cartilage. If irritation is increased, by displacing the fragments and rubbing the soft parts, the result is cartilage beneath the periosteum, which is subsequently converted into bone. To prove that bones can unite without periosteum, they removed a cylindrical piece of periosteum from a long bone in an animal. After the wound had completely healed, the bone was fractured at the point where it had been denuded of its periosteum. The fracture united by bone after the usual time.

[The histology and formation of callus were illustrated by diagrams on the black-board.]

It is no longer necessary to make a distinction between provisional or temporary, and definitive or permanent callus, as they are both the product of bone-producing tissue, and assist in the restoration of the continuity of the broken bone. A fracture may heal perfectly without the formation of provisional callus, and on the other hand the tissues which were supposed to furnish the provisional callus may, under certain circumstances, furnish a permanent callus.

The amount of callus thrown out in every instance depends on: 1. The general condition of the patient. 2. The location and structure of the fractured bone. 3. The amount of local injury. 4. The degree of displacement. 5. The perfection of immobilization.

As a rule, a minimum amount of callus is produced when the patient is suffering from any wasting or acute febrile affection, or is the victim of any so-called constitutional diseases; when the broken bone is very compact and located near the surface of the body; when the injury was slight with little or no displacement, and when during treatment the broken ends have been kept at rest and in constant and in uninterrupted co-aptation.

Opposite conditions are followed by an exuberant production of callus. The influence exercised by para-periosteal tissues in determining the amount of callus is well illustrated in fractures of the tibia and ulna; where the bone is subcutaneous little or no callus is found, while in places where it is deeply covered by muscular and aponeurotic tissue the amount of callus is great, in some instances so great that it fills the entire inter-osseous space, forming a bridge of bone across it, permanently cementing the fibula or radius, as the case may be, to the broken bone.

To obtain bony consolidation after a fracture certain well recognized conditions are necessary: 1. A sufficient blood-supply to the part. 2. Unimpaired innervation of the part. 3. Placing and maintaining the fragments in contact, or at least in such close proximity that the callus thrown out from both extremities can meet and establish a bony bridge between. Injury of any principal vessel or nerve of a limb, as a complication of any fracture, does not only endanger the integrity of the limb but may constitute an important element in the production of non-union.

Injury of the nutrient vessels of long bones has

no influence in determining non-union, as has been claimed by several writers, inasmuch as the combined statistics from the practice of different surgeons do not sustain this assertion. An excessive supply of blood in the part—either from an undue afflux of blood, the consequence of an excessive irritation about the seat of fracture, or from obstruction to the venous return—frequently affects callus formation in a detrimental manner. These conditions often interfere with the normal reparative process, the histological elements which are intended to furnish the callus not undergoing the typical embryonal tissue transformation.

That an opposite condition may also unfavorably influence callus formation was demonstrated to me plainly during the treatment of the following case:

Case I. Very oblique fracture of leg at the junction of the middle with the lower third; delayed union. C. L., æt. forty, was treated at the Milwaukee Hospital. The fracture was caused by direct violence. The sharp point of the upper fragment showed a strong tendency to project forward, which could not be overcome by any of the ordinary appliances. Extension in the straight position was tried with no better results. At last I applied a Volkmann's railroad splint, and placed the limb upon a steep single inclined plane, using extension by a heavy weight at the same time, which finally succeeded in keeping the bones in good position. It became apparent that very little callus formed, and four months after the injury, on careful examination, I found free motion between the fragments. I became alarmed at the prospect of getting a false joint, and determined to secure bony union, if need be at the expense of considerable deformity. I applied a plaster of Paris splint and allowed the patient to leave the bed and walk on crutches. Callus appeared promptly, and in two months more bony union had taken place, of course with some projection of the upper fragment forward.

Prolonged elevation then of a limb after fracture, by diminishing the blood-supply, may constitute a cause of delayed or non-union, and I have since been careful not to continue this position for too long a time.

The first step towards repair of a fracture is an osteo-plastic inflammation of the fractured ends of the bone. The vessels increase in size and number, and the medullary tissue in the central canal and the medullary spaces in bone proliferates, its histological elements being converted directly into bone by deposition of the inorganic salts.

Ossification of the medullary tissue obliterates the medullary cavity for some distance at the end of both fragments; the canal is, however, invariably restored, after union has taken place, by a slow process of absorption. The callus from the surface of the fractured ends, the intermediate callus as it is sometimes called, is slow in its appearance, but is usually directly transformed into bone, and is intended for the material utilized in the ultimate restoration of the continuity of the bone. Nature usually supplies a surplus of callus, which is gradually removed by absorption as soon as firm union has taken place, but which for the time being answers an exceedingly useful purpose in immobilizing the fragments.

The time required for bony consolidation to take place varies in different individuals and under diverse circumstances. All conditions which facilitate a prompt formation of callus, and at the same time reduce the amount to the minimum requisite, are instrumental in hastening bony consolidation. The time necessary for firm union to take place is usually longer than we have been taught. According to Gurli the time required is proportionate to the diameter of the broken bone. The phalanx of a finger may unite firmly in four weeks, and it may require six months to accomplish the same result in a fracture of the femur. It is dangerous practice to remove retentive measures too early, more partic-

ularly in fractures of the humerus and femur; carelessness in this regard has frequently been punished by formidable deformity arising from yielding of imperfect callus. Non-union may follow a fracture either when the reparative material fails to be produced, or when the broken ends are placed and kept in a position which renders it physically impossible for the callus to unite them. For the first cause the surgeon can never be held accountable, as it is always owing to complications attending the injury, or defective nutrition in the patient himself. The second cause may arise from: 1. The location of the fracture. 2. Want of co-operation on the part of the patient. 3. Ignorance, carelessness, or negligence on the part of the surgeon.

Fractures located within joints are very frequently followed by non-union, not so much on account of unfavorable anatomical and physiological conditions, as from the difficulties encountered in maintaining accurate and perfect co-aptation for a sufficient length of time. The means at our command are not adequate to meet successfully the necessary indications.

Except in fractures within joints, pseud-arthritis is most likely to occur after fractures of the humerus, femur and ulna.

In private practice the removal of the second cause is often beyond our control. The more refractory the patient the more unremitting and careful must be the treatment. The surgeon must always be on his guard to make the first examination thorough, to enable him to arrive at a correct diagnosis. Disregard of this rule has often been followed by unpleasant consequences for the patient and the surgeon. A diagnosis to be satisfactory must establish: 1. The existence of fracture. 2. The seat of fracture. 3. The presence or absence of complications. 4. The fact that no soft tissues intervene between the broken ends of the bone.

Should any doubt exist in the mind of the sur-

geon, either in regard to diagnosis or the adoption of a certain course of treatment, it must be considered not only prudent but necessary to call in early counsel, for the benefit of the patient and the protection of the attendant. The best possible protection against mal-practice suits is to treat every case as though you were expected to defend your treatment in court. The following are the principal causes which have been enumerated as giving rise to false joints:

General	{	Rachitis,	Syphilis,
		Scorbutus,	Acute febrile affections,
		Wasting diseases,	Pregnancy,
		Prolonged lactation.	
Local	{	Interposition of soft tissue bet. fracture,	
		Separation of fragments,	
		Imperfect immobilization,	
		Imperfect circulation from concomitant swelling, too tight dressing or position of limb,	
		Obliquity of fracture,	
		Complication of fracture.	

I have not enumerated old age as a cause for delayed or non-union. Statistics show that these accidents are found almost exclusively in young people at the age of twenty to thirty-five years. With the exception of joint fractures, fractures unite promptly and in a short time in the aged. Senile osteo-porosis may be considered a favorable condition for a callus formation.

A great diversity of opinion prevails among surgeons in regard to the influence of general conditions on the production of callus. Some claim that non-union is almost invariably due to general causes. I recollect very well the remark of Geheimrath von Nussbaum on this subject. In a lecture on this subject he claimed that nearly all, if not all fractures, that fail to unite by bone occur in patients suffering from some constitutional taint, more especially syphilis. He referred to several cases where no attempt at union took place under the most favorable local conditions, and where

a course of mercurial inunction was promptly followed by bony consolidation. I recollect at least one case where a false joint was threatened in a patient where the fracture occurred during pregnancy.

Case II. Fracture of ulna during pregnancy; delayed union; Dumreicher's treatment; cure.

The patient fractured the ulna at the junction of the middle with the upper third. She was pregnant six months with her fourth child. There was no difficulty in reducing the fracture, or in maintaining co-aptation with the customary dressing. The production of callus did not appear in a satisfactory manner, and ten weeks after the accident I found on careful examination free motion of one fragment on the other. I now rubbed the fragments freely together and applied von Dumreicher's dressing for hastening the production of callus, making pressure above and below the point of fracture by means of four small compresses. The space between the upper and lower compresses directly over the seat of fracture became œdematous in a few days, which was soon followed by a mass of callus, and bony consolidation was complete about the time of delivery.

While it is impossible to deny the influence of general causes in interfering with normal callus production, I would array myself on the side of those who make diligent search for local causes in every case of non-union. For the purpose of preventing such an unfavorable issue, it is advisable for the surgeon to bear the following points in mind in any fracture where such an occurrence might follow:

1. To satisfy himself that the broken surfaces are in contact.
2. To insure a free circulation in the part by avoiding tight dressings, and placing the limb in a proper position.
3. To avoid frequent dressing. The fractured limb should be inspected often, but the fragments when in proper place

should be disturbed as little as possible until union has taken place. Frequent change of dressing is meddlesome surgery, and will be certain to prove not only unnecessary but possibly harmful in the end.

Delayed union calls for local stimulation by external friction, change of position of limb, or rubbing the fragments together. Dumreicher's dressing can always be applied with advantage in these cases. Non-union can be said to have occurred after the usually allotted time for bony union to take place has elapsed, and the treatment instituted for delayed union has been found unavailing. As regards time, no fixed rule can be adopted. In some cases we may be able to satisfy ourselves after three or four months that no union will take place, and on the other hand cases have been reported where union took place a year and a half after the accident.

From a pathological stand-point we may distinguish four principal varieties of false-joints.

1. Ends of fragments atrophied, no connecting medium. The fragments may point directly towards each other, but separated by an interval, or they may overlap each other, and still in other instances they may be separated by an interposing band of the surrounding soft tissues—muscle, fibrous tissue, tendon, ligament, etc.

2. Ends of fragments atrophied but united by a bridge of connective tissue. In these instances the functional result is not so bad as in the first variety. The usefulness of the limb depends on the length and thickness of the connecting ligament. Nature has made an effort to restore the continuity of the bone, but the process has stopped short of ossification.

3. Ends of fragments less atrophied—ligamentous union with isolated deposits of bone. Here the effort has been in the right direction, but the result imperfect.

4. Ends of fragments not atrophied, sometimes enlarged—directly opposite each other flattened or slightly rounded, connected by a peri-fragmentary ligament. Bone surfaces separated by a synovial sac. These are the exceptional cases where nature inserted the anatomical elements of a true joint in lieu of a bony callus.

The diagnosis of a false joint is not attended by any difficulty. A false point of motion at the seat of fracture at a time sufficiently remote from the time the injury was received, when we can reasonably assume that the process of repair has been arrested, is all that is required to establish a diagnosis.

Excluding from consideration non-union of joint-fractures, it can be said that the prognosis depends on two things: 1. The time that has elapsed since the injury was received. 2. Amount of separation and degree of atrophy of ends of fragments.

It can be stated as a rule that the greater the interval between the injury and the operative procedure, the greater the atrophy of the limb and the bone ends, conditions which seriously affect our prognosis.

The treatment, so far as it has for its object the restoration of the anatomical defect, belongs exclusively to the domain of operative surgery. In some instances a false joint does not materially interfere with the function of the member; in other cases, where an operation is not deemed advisable, some form of an apparatus can be applied which will act as a substitute for the defective bone. In selecting from the operations which are usually resorted to in the treatment of false joints, we should be careful to ascertain as nearly as possible the exact local conditions at the seat of fracture. All methods of treatment aim at: 1. Production of osteo-plastic inflammation of the fractured ends of the bone. 2. Accurate coaptation.

Inter-fragmentary injections. This form of treat-

ment is indicated when the fragments are in close apposition, the ends of the bone not much atrophied and the treatment not too distant from the time of injury. The operation is done with a Pravaz syringe with a sufficiently long and stout needle. As injection fluid, lactic and acetic acids appear to have yielded the best results. Hueter recommends lactic acid for this purpose in strong terms. He is of the opinion that this substance has a specific action in exciting osteo-plastic inflammation in bone. The injection should be made between the bone-ends, and the fluid made to permeate the whole space between them. Like some of the other operations, this procedure may be repeated every week or two should signs of reaction appear, inasmuch as the measure is harmless and not attended by much suffering.

Subcutaneous incision. This little operation can be done under the same circumstances as the preceding one, and consists in passing a small tenotome subcutaneously down to the seat of fracture, dividing any fibrous bands that may exist between the bone, and scarifying the bone-ends.

Acupuncture. A stout steel needle is passed down to the seat of fracture, and by moving the point in different directions the intervening space and the bone-ends themselves are punctured with the instrument.

Electro-puncture. An electric current is passed through acupuncture needles. This method offers no special advantages.

Seton. Introduced into practice by Physick, this form of treatment soon received an extensive trial on part of the profession. The dangers attending its use and the uncertainty in its results very justly condemn its use at the present time.

Perforation of the ends of the bone. This operation is usually accredited to Dr. Brainard, who in a number of published articles claimed it as his own. Dieffenbach, however, performed the operation

twice in 1841, antedating Brainard's operation by a number of years. The operation is the one usually resorted to at the present time. If carefully done it is devoid of danger, and has yielded good results. The operation is performed by making a subcutaneous tunnel with a tenotome through the soft tissues down to the seat of fracture, inserting a perforator of suitable size; both ends of the bone are perforated a sufficient number of times, the number of perforations depending somewhat on the size of the broken bone. It is advisable to use an instrument with a triangular point, as being less liable to break than one with a flat point. The perforations give rise to osteo-plastic inflammation, and if no interposition of soft parts exists, and the fragments are in close contact, the operation is usually followed by success. A repetition of the operation is often necessary.

For the purpose of illustrating the efficacy of simple drilling in favorable cases, I will relate the following case:

Case III. Ununited fracture of femur; drilling; cure. Patient was about forty-five years of age, and had suffered from compound fracture of femur at the juncture of the lower with middle third. Wound healed promptly. Fracture treated by extension. At the end of nine weeks it was found that no union had taken place, and the attending surgeon was promptly sued for mal-practice, and a judgment for \$4,000 recovered against him. I saw the man five months after the injury, and found false point of motion at the seat of fracture. The limb was shortened two and one half inches, the fragments overriding in such a manner that the upper fragment could be felt anteriorly and towards the inner side, while the lower fragments, apparently much atrophied, could be found posteriorly and towards the outer side. The upper fragment appeared to be covered with callus. The fragments were freely and forcibly moved upon each other.

A perforator was introduced from the outer aspect of the thigh, and at least five perforations were made through the same opening in the skin and traversing in different directions some transfixing both ends of the bone. The limb was dressed as for recent fracture, with eighteen pounds of weight for extension.

Bony union was complete two months after the operation.

Introduction of ivory pegs. This operation was devised by Dieffenbach after he became dissatisfied with simple perforation. The operation is performed in a similar manner, only that ivory pegs are driven through the perforations into the interior of the bone, and allowed to remain until a sufficient amount of inflammation has been excited. It was urged by Brainard against this operation that foreign bodies introduced into bone do not give rise to an increase of tissue formation, but that, to the contrary, they produce destruction and absorption of bone. Clinical results and experiments on the lower animals, however, have sufficiently demonstrated the fallacy of this assertion. In numerous cases where simple perforation proved useless, Dieffenbach's operation was followed by success. In my experiments on animals I have invariably observed osteo-plastic inflammation of the bone along the track of iron, bone or ivory nails, provided the foreign body was introduced under antiseptic precautions.

Nailing of fragments. In cases of very oblique fractures, or when the fragments override each other, the object to be accomplished can be reached with more certainty if the perforations are made to transfix both fractured ends, and, by driving in absorbable aseptic bone nails, the fragments are securely fastened together. This operation combines all the advantages of Brainard's and Dieffenbach's operations, and at the same time secures accurate coaptation and immobility. Volkmann

has modified this operation by removing a rectangular piece of bone from opposite sides of each fragment, and, after fitting the surfaces accurately together, transfixing them by two ivory nails. This operation furnishes a large surface of bone, and secures accurate apposition and perfect immobility between fragments. Aseptic bone nails should be used in preference, and they should never be allowed to project beyond the surface of the bone. If introduced antiseptically they will be absorbed completely after they have accomplished the object of their introduction.

Case IV. Fracture of ulna ununited; subcutaneous nailing of fragments; cure.

J.A., aged twenty-five; fractured both bones of the fore-arm six months ago. Radius united with considerable exuberant callus. Ulnar fragments in good position, false point of motion near the middle of the bone. Made a very oblique perforation through both fragments with a small drill and nailed the fragments together with a bone nail. About two weeks after the operation considerable swelling appeared at the seat of fracture, motion became less and less, and two months after operation bony union had taken place. The nail was not seen after the operation.

Resection of bone ends. This operation was first performed in the year 1760, at the suggestion of Mr. White, of Manchester. It found ready adoption, and was frequently performed by English and Continental surgeons. It soon, however, became evident that it was not devoid of danger, and before the introduction of antiseptic surgery it had fallen into well merited disrepute. It necessitates the conversion of a simple into a compound fracture, with all its dangers. The great advantages of antiseptic surgery are rendered peculiarly prominent in this connection, inasmuch as the surgeon makes the fracture compound during the operation, but makes it again simple after its completion. This opera-

tion is the only one which promises success in cases where the fragments are separated by interposition of soft parts; again, where the fragments are excessively atrophic, or are widely separated and cannot be brought into apposition by any other means; likewise in cases where a new joint has formed. The important rules to be observed in this operation are: 1. To save the periosteum. 2. To procure as large a bone surface as possible. 3. To remove carefully all interposed tissue. 4. To secure apposition and immobility by wiring or nailing the fragments together.

As the fractured ends are usually tapering and atrophied, and the medullary canal closed for some distance, it is unavoidable, for the purpose of saving bone tissue and at the same time procuring a large surface for apposition, to make the bone section, obliquely, or Volkmann's "step" resection. It has been said in opposition to the silver wire suture that it is very apt to cause necrosis, and every one who has used it can testify to the difficulty in removing it. To obviate these difficulties it has been proposed to transfix both fragments with a gimlet, and leaving the instrument *in situ* fasten the fragments with a figure of 8 silver wire passed over the point and the proximal side of the gimlet. When the gimlet is removed the silver wire ligature falls off. The best material for fastening the fragments together are aseptic bone nails.

If the bone section is made oblique, or rectangular, the fragments can be transfixed by two bone nails. If the bone section is straight, transfixion can be accomplished by one very oblique nail, or what is still better, by making a perforation in the axis of the bone from the middle of each resected end, and fastening them together by a bone nail. If the diameter of the bone is large, more than one nail can be used in this manner. The following case is reported for the purpose of illustrating the obstinacy of some of these cases in resisting all kinds of treatment:

Case V. Pseud-arthritis humeri; resection and wiring; failure.

This patient was twenty years of age, and fractured the humerus two years before he came under my observation at the Milwaukee Hospital. The arm and fore-arm were perfectly useless and very much atrophied. On examination it was found that the fracture had taken place about three inches above the elbow-joint. Rubbing the fragments together and perforation had been repeatedly performed without any evident success.

Under the influence of an anæsthetic an incision was made over the outer aspect of the arm, carefully avoiding the musculo-spiral nerve. The fragments were loosely connected by a ligamentous band and extremely atrophied, especially the lower fragment, which for some distance did not exceed the diameter of an ordinary lead pencil. The periosteum was reflected, and the intervening tissue with the bone ends freely excised, and the fragments brought into apposition with a silver wire suture.

This operation was performed before antiseptic surgery came into general use, hence the reaction was quite severe. A fenestrated plaster of Paris splint was applied. The inflammation about the seat of fracture, however, did not appear to affect the bone, which evidently remained in the same atrophic, indolent condition. After several months of patient treatment, the wire was removed, but no improvement appeared to have taken place, and as the patient refused further operative measures he was discharged from the hospital.

In this case the patient blamed tight dressings for the bad result, and the atrophied condition of the whole member, and a tight circular bandage he brought with him to the hospital would tend to corroborate this opinion.

Case VI. Pseud-arthritis humeri; resection; wiring; partial success; Dieffenbach's operation; bony union.

The patient, a young man in good health, had fractured the humerus about eighteen months before the operation. The fore-arm was extremely atrophied and perfectly useless. The extensor muscles were paralyzed. Fracture at the junction of the middle with lower third. As all the ordinary measures had proved unsuccessful in the hands of others, resection and wiring the fragments together was done as offering the only prospect for a favorable issue. The bone was again approached by an incision made over the outer aspect of the arm. The fragments were found atrophied and separated by a mass of connective tissue. The bone ends and interposed tissues were freely removed, and the fragments wired together. The operation was done under antiseptic precautions, and no undue reaction followed. The wire was removed about six weeks after the operation; union had commenced but was not firm. On two different occasions subsequently, a sharp silver-plated-metallic nail was driven into each fragment, which finally resulted in firm bony union.

A few words in regard to pathological fractures. Writers and teachers unite in asserting that fractures arising from pathological causes usually fail to unite. While this assertion holds true as far as fractures are concerned which arise from neoplastic (cancer, sarcoma) deposits in bone, it certainly does not apply to spontaneous fractures, which sometimes occur during inflammatory affections of bone. To illustrate I will report only one case out of a number which have come under my observation:

Case VII. Acute osteo-myelitis of femur; spontaneous fracture; bony consolidation.

The patient was a lad nine years of age, suffering from acute diffuse osteo-myelitis of the femur. An abscess was opened over the middle and outer aspect of the thigh four weeks after the first symptoms had shown themselves. Two weeks

subsequently, on dressing the limb one day, I ascertained that the bone had given way about its middle. Extension by weight and pulley was applied and sand-bags were placed on each side of the limb to prevent eversion. Suppuration continued profuse for a number of weeks, but firm bony union had taken place three months after the accident occurred. Two years later I removed almost the entire shaft of the femur, which was found included in a thick and strong involucrum. The new femur is slightly curved at its middle with the concavity inward, and is at present (six years after fracture) a full inch longer than the opposite one. In some of these cases the recuperative powers of *vis medicatrix naturae* are truly wonderful, the same agencies which have been the cause of destruction being in turn utilized in the process of reconstruction.



